HEATHKIT®

VACUUM TUBE
VOLTMETER

MODEL IMW-11

SSI 3

OWNER'S MANUAL

THE HEATHKIT® VACUUM TUBE VOLTMETER

MODEL IMW-11

Every feature of this handsomely styled HEATHKIT Vacuum Tube Voltmeter is designed to bring you high accuracy, dependable performance, and convenient operation. Its carefully engineered time-proven circuitry, top-quality name-brand components, and clean, modern styling assure long, faithful service and trouble-free performance. It will prove an invaluable aid in all types of measurement work encountered in the electronics field.

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HEATHKIT

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FEATURES

EASY OPERATION

The IMW-11 is designed for fast, easy reading of all measurements. A large 4-1/2" meter with two-color scale and high-contrast panel screening show at a glance the correct scale and range in use. A new, slim, all-purpose test probe with switch on the probe body, eliminates changing test leads when alternately checking AC voltage, resistance, or DC voltage. A hook is provided to permit clipping probe to circuit for "hands-free" operation.

HIGH ACCURACY

The 1% precision multiplier resistors, sensitive 200 microampere meter movement, and 11 megohm input impedance featured in the IMW-11 assures high accuracy in every application. Its time-proven circuitry and stable, reliable performance has made it an instrument you will be proud to own and use.

WIDE VOLTAGE AND RESISTANCE RANGES

The wide voltage and resistance ranges covered by the IMW-11 fill a multitude of requirements for specialized as well as routine circuit investigations: Measures AC volts (rms), AC volts (Peak-to-Peak), DC volts, Resistance, and Decibels...an extremely versatile instrument.

CLEAN, FUNCTIONAL STYLING

The professional appearance of the IMW-11 reflects the quality of its design. The neat, uncluttered panel layout has just four controls for easy operation. Zero and Ohms adjust controls have small phenolic shaft knobs to prevent accidental change in settings, and the function and range switches with pointer knobs show clearly the function and range in use to minimize errors.

HIGH QUALITY THROUGHOUT

Only highest quality components and materials have been used in the assembly of the IMW-11 to assure top-notch performance. Given the care deserving a precision instrument of this type, the IMW-11 will provide years of dependable, trouble-free service.

INTRODUCTION

The HEATHKIT Model IMW-11 Vacuum Tube Voltmeter is intended for use by servicemen, engineers, and maintenance men to make accurate measurements of DC+, DC-, AC rms and peak-to-peak voltages, plus resistance. The design is simple and rugged, yet accurate. The instrument employs vacuum tubes for rectification and amplification on all measurement functions to insure good sensitivity and stability of operation. Precision resistors are used in the voltage divider networks to provide high accuracy.

The confusing tangle of test leads coming from the front panel of most VTVMs is eliminated by the use of a combination AC-OHMS-DC switching test probe and a single jack input connection for both test probe and ground leads. The 1 megohm resistor in the probe is switched into operation when the probe switch is set on DC. This isolating resistor allows DC component voltages to be measured separately, even when high frequency AC voltages are present at the test point

The VTVM has a very high input impedance (11 megohms on DC and 1 megohm shunted by 3$ $\mu\mu$f on AC). Consequently, the circuit in which the voltage is being measured will not be significantly loaded by the VTVM. Most nonelectronic voltmeters (VOM) have a much lower input impedance over the most frequently used ranges of test voltages. Consequently, when a VOM is used to measure voltages in high impedance circuits, the indicated voltage will be appreciably less than the actual voltage. The amplifier section of the VTVM also enables the VTVM to accurately measure much higher resistances than can be measured with a VOM.

OPERATION

NOTE: Install a standard size "C" battery in the battery holder of this instrument.

Install the battery by first removing the cabinet. Start the top (+) end of the battery into the battery cup and then pull the spring out and over the bottom (-) end of the battery. Now push the spring and battery in so the spring, battery, and battery cup are all in line.

NOTE: When the VTVM is first turned on, the meter pointer will normally deflect to full scale and then return to, or near, the zero position. This is caused by the 12AU7 tube stabilizing during warmup.

COMBINATION PROBE

The combination AC-OHMS-DC test probe eliminates two of the usual three test jack installations in the VTVM front panel. The probe is set to AC-OHMS when the Function switch is on AC or OHMS, and on DC when the Function switch is on DC+ or DC-. The probe tip design makes it unnecessary to actually hold the probe to the circuit. Instead, the probe can be clipped onto any lead in the circuit, as shown in Figure 1, giving the operator another free hand. To disconnect the probe, the probe is gently twisted until it comes free from the test circuit.

Figure 1

CAUTION: It is good practice to observe certain basic rules of operating procedure anytime voltage measurements are to be made. Always handle the test probe by the insulated housing only and do not touch the exposed tip portion.

The metal case of this instrument is connected to the ground of the internal circuit and for proper operation, the ground terminal of the instrument should always be connected to the ground of the equipment under test. There is always danger inherent in testing electrical equipment and therefore the user should clearly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment.

When measurements are to be made at high voltage points, it is good practice to remove operating power before connecting test leads. If this is not possible, be particularly careful to avoid accidental contact with nearby objects which could provide a ground return path. When working on high voltage circuits, play safe. Keep one hand in your pocket to minimize accidental shock hazard and be sure to stand on a properly insulated floor or floor covering.

Voltages encountered in the measurement range of this instrument are seldom directly lethal but the secondary effects of a shock, such as involuntary reaction causing a fall or heart attack, can be very serious.

DC VOLTAGE MEASUREMENTS

The VTVM has many advantages over nonelectronic volt-ohmmeters. The greatest advantage is the high input resistance. This enables much more accurate readings to be obtained in high impedance circuits such as resistance coupled amplifiers, oscillator grid circuits, and AVC lines.

To illustrate this, assume a resistance coupled audio amplifier with a .5 megohm plate load resistor operating from a 100 volt plate supply as shown in Figure 2. Assume that the plate voltage is 50 volts and therefore the tube acts as a .5 megohm resistor. Measuring the plate voltage with a conventional 1000 ohms-per-volt instrument on the 100 volt scale, the meter can be considered a 100,000 Ω (.1 megohm) resistor in parallel with the tube. The voltage on the plate is then about 14 volts, and is shown as such by the meter. This is due to the shunt resistance of the low resistance meter. Using the VTVM on any scale setting, the full 11 megohms is placed in

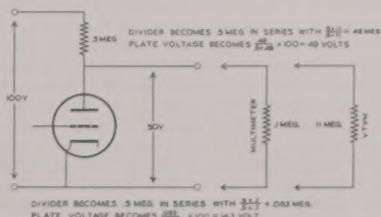

Figure 2

parallel with the tube. The voltage on the plate is then about 49 volts or 2% lower than the normal operating voltage. Thus accurate readings can be obtained only when the high resistance provided by a VTVM.

To measure DC voltage with the VTVM, connect the COMMON (black lead) to the common or "cold" side of the voltage to be measured. Set the Function switch to DC+ or DC- as required and set the Range switch to a range greater than the voltage to be measured, if known. If unknown, set to 1500 V. With the test probe set on DC, touch the "hot" side of the voltage to be measured. If the pointer moves less than 1/3 of full scale, switch the Range switch to the next lower range. For greatest measurement accuracy, all voltage measurements should be made on the range which will accommodate the largest possible deflection of the meter pointer.

The available voltage ranges are intended to provide coverage for the radio and TV serviceman. For example, the 1.5 V range will be useful in measuring bias voltages, DC heater voltages, etc. The 5 V and 15 V ranges will again prove their worth in bias measurement functions. The 50 V and 150 V ranges will find greatest application in the measurement of voltages encountered in universal or transformerless type radio circuits. The 500 V range can be used on conventional transformer operated power supplies found in radio and TV circuits, and this voltage range eliminates the necessity for switching from one range to another when measuring plate and screen supply voltages. On many occasions, the higher voltage ranges will prove useful.

DC accelerating potentials developed in TV receiver flyback power supply systems can be safely measured through the use of the HEATH-KIT High Voltage Probe in conjunction with the VTVM. This probe with its precision multiplier resistor mounted in a safety plastic probe housing will provide a multiplication factor of 100 for the VTVM DC ranges. 30,000 volts DC is generally considered the safe upper limit for these measurements.

CENTER SCALE "0" POSITION

Your VTVM features a convenient center scale zero position. The adjustment range of the ZERO ADJ control will permit center scale zero deflection of the meter pointer when Function switch is set to DC+ or DC-. Center scale zero may not be obtained at both positions.

The center scale zero will be useful as a null indicator in discriminator adjustments, for bias measurements or any application where polarity reversals may occur.

AC VOLTAGE MEASUREMENTS

To measure AC voltage, connect the COMMON (black) lead to the common or "cold" side of the voltage to be measured. Set the Function switch to AC and set the range switch to a range greater than the voltage to be measured, if known. If unknown, set to 1500 V. With the test probe set on AC, touch the other side or "hot" side of the voltage to be measured. If the meter moves less than 1/3 of full scale, switch to the next lower range. The maximum AC voltage that can be safely measured is 1500 volts, and this limit must not be exceeded. The meter scales are calibrated in both rms and peak-to-peak voltages. When values of sine waves are measured, rms voltages are read and the corresponding values in peak-to-peak volts are equal to 2.83 times the rms voltage.

If the range switch is set at 15 V and a sine wave of 10 rms volts is applied to the instrument, the meter pointer will indicate 10 rms volts and 28.3 peak-to-peak volts. This direct-reading, time-saving feature makes the usual calculation to transpose from one scale to another unnecessary.

This VTVM is an extremely sensitive electronic AC voltmeter and as the human body picks up AC when near any AC wires, the meter will indicate this pickup. Never touch the probe when on the lower ranges. Zero should be set with the probe shorted to the common clip. Because of this characteristic of extreme sensitivity, it is possible that the accuracy of AC measurements on the 1.5 V range only may vary as much as 15% and this possible deviation should be taken into consideration. On the remaining ranges, the accuracy should be well within the 5% specified.

RESISTANCE MEASUREMENTS

To measure resistance with the VTVM, connect the COMMON (black) lead to one side of the resistor or circuit to be measured. Set the Function switch to OHMS and set the Range switch to a range that will provide a reading

as near mid-scale as possible. Set the OHMS ADJ control so the meter indicates exactly full scale (infinity). With the test probe set on OHMS, touch the other side of the resistor or circuit to be measured. Read resistance on the OHMS scale and multiply by the proper factor as shown by the Range switch settings.

NOTE: Although a battery is used to measure resistance, the indication is obtained through the electronic meter circuit and therefore the VTVM must be connected to the AC power line and turned on. Establish the habit of never leaving the instrument set in the OHMS position as this could greatly shorten the life of the ohmmeter battery, particularly if the test leads are accidentally shorted together when lying on the service bench.

USING THE DECIBEL SCALE

Because the human ear does not respond to volume of sound in proportion to signal strength, a unit of measure called the "bel" was adopted. The bel is more nearly equivalent to human ratios. Normally the reading is given in 1/10 of a bel or a decibel. Various signal levels are adopted by various manufacturers as standard of zero decibel. The VTVM DB scale (decibel) uses a standard of 1 milliwatt into a 600 Ω line as zero decibels. This corresponds to .774 volts AC on the 1.5 V scale. From this figure, the various AC ranges of the VTVM may be converted to DB, with adequate accuracy, by the following chart:

AC VOLTS SCALE	DECIBEL SCALE
0-1.5 volts	Read db directly
0-5 volts	Add 10 db to the reading
0-15 volts	Add 20 db to the reading
0-50 volts	Add 30 db to the reading
0-150 volts	Add 40 db to the reading
0-500 volts	Add 50 db to the reading
0-1500 volts	Add 60 db to the reading

As the decibel is a power ratio or voltage ratio, it may be used as such without specifying the reference level. Thus for instance, a fidelity curve may be run on an amplifier by feeding in a signal or variable frequency but constant amplitude. At a reference frequency of say 400 cps, adjust the input to give a convenient indication (zero db, for instance) on the VTVM connected to the output. As the input frequency is varied, the output variation may be noted directly in DB above and below the specified reference level. NOTE: When measuring complex AC wave shapes, such as ripple, hum, distorted and square waves, the indication is 35% of peak-to-peak.

READING THE METER SCALE

The voltage markings for the Range switch refer to the full scale reading. The scale is marked 0-15 and 0-50 for voltage. On the 1.5 V range, read the 0-15 scale and move the decimal one place to the left. Thus for example, a reading of 8 would represent a voltage of .8 volt. On the 5 V range, read the 0-50 scale and move the decimal point one place to the left, that is, drop

Figure 3

the zero. A reading of 40 would represent a voltage of 4 volts. On the 15 V range, read the 0-15 scale directly. EXAMPLE: A reading of 4 represents a voltage of 4 volts. On the 50 V range, read the 0-50 volts directly. On the 150 V range, read the 0-15 scale and add one zero. EXAMPLE: A reading of 12 represents a voltage of 120 volts. On the 500 V range, read the 0-50 scale and add one zero. EXAMPLE: A reading of 40 represents a voltage of 400 volts. On the 1500 V range, read the 0-15 scale and add two zeros. EXAMPLE: A reading of 8 represents a voltage of 800 volts.

NOTE: The meter markings do not mean that the upper scale indicates DC volts and the lower scale AC volts. Rather, it means that either scale will read AC volts or DC volts, depending on the setting of the Function switch.

The resistance marking or OHMS scale refers to the lowest resistance range, RX1. For the other ranges, add the proper number of zeros.

Add two zeros for RX100, four zeros for RX10K and six zeros for RX1 MEG. On the RX1 MEG range, the scale can also be considered to read directly in megohms.

ACCURACY

The accuracy of the meter movement is within 2% of full scale which means that on the 1000 V range, for instance, the accuracy of the movement will be within 20 volts at any point on the scale. On DC, the accuracy of the multipliers, 1%, may be additive, resulting in an inaccuracy of within 3% of full scale.

On AC, the accuracy of the rectifier circuit contributes variations which result in an accuracy of within 5% of full scale. Bear in mind that on the lowest AC voltage range, 1.5 V extreme sensitivity will introduce additional variation through stray pickup. Therefore, on the 1.5 V range, it is possible that the accuracy may be in the order of 15% on AC only.

The accuracy on the OHMS range depends on the meter accuracy, the ohms multiplier accuracy (including the internal resistance of the battery) and the stability of the battery voltage. On the RX1 scale, the internal resistance of the battery and the battery voltage both vary as a result of the current drawn by the resistance under test. For greatest accuracy, tests on low resistance values should be made as quickly as possible. On the higher ohms range, the accuracy depends practically on the multipliers which are 1% and the meter movement accuracy, 2%. Because of the non-linear OHMS scale, the resulting accuracy is not readily expressed in a percentage figure, but greatest accuracy is obtained at mid-scale readings.

NOTE: When comparing this instrument with another VTVM, consider that the accuracy of the other instrument may deviate in the opposite direction. Therefore, when comparing two instruments of 5% accuracy, the total difference may be 10%. Critical comparisons should only be made against certified laboratory standards.

ADJUSTMENT

Your IMW-11 VTVM has been calibrated accurately at the Factory. No additional adjustments should be required before the VTVM is put into operation. After extensive use, or if one of the tubes is replaced, the VTVM can be recalibrated easily, using the following procedure. If a new tube is installed in the VTVM, be sure to let the instrument operate for 48 hours with the new tube before recalibration. This will allow the new tube to stabilize.

Turn the instrument off and make sure that the mechanical zero position of the meter pointer is correct. If not, adjust as follows:

( ) Place the instrument in normal operating position. Turn the plastic screw on the meter face with a screwdriver while gently tapping the meter face with one finger until the pointer coincides with the zero line on the left side of the scale. Turn the instrument on again.

ZERO ADJUST

( ) Set the Function switch to DC+. Check operation of the ZERO ADJ control. Turning this control should move the meter pointer part way up scale. Set the pointer to zero at the left side of the scale and check for zero positioning when the Function switch is changed to DC-. It should be possible to obtain a ZERO ADJ control position that will permit the meter pointer to remain stationary when switching through from DC+ to DC-. If there is an appreciable zero shift of more than two divisions on the scale, it should be regarded merely as an indication that additional aging of the 12AU7 tube is required. This aging can be obtained by leaving the instrument turned on for a period of 48 hours or more, or through continued use of the VTVM with periodic calibration.

DC CALIBRATE

( ) Remove the cabinet and remove the flashlight cell.

( ) Insert the test lead phone plug. Set the Function switch to DC+, the Range switch to 1.5 V and the probe to DC. Connect the probe and common test leads to the flashlight cell and adjust the DC Calibrate control so that the meter pointer falls directly over the very small red dot on the meter face. Approach the red dot going up scale by turning the screwdriver control and watch the meter read 1.4 volts, and 1.5 volts, and

then the red dot. As soon as the red dot is reached, stop turning the DC Calibrate control. Remember that the Range switch must be set on 1.5 V for this adjustment.

OHMS CHECK

( ) Turn off VTVM and unplug the VTVM. To install the battery, start the top (+) end of the battery into the battery cup and then pull the spring out and over the bottom (-) end of the battery. Now push the spring and the battery in so the spring, battery, and battery cup are all in line. Turn on the VTVM and set the Function switch to OHMS. Set the OHMS ADJ control for full scale (infinity). Set the probe switch to AC-OHMS and touch the probe to the common test clip. The meter pointer should drop to zero at the left end of scale (no resistance).

WARNING: 117 volt AC line is dangerous. Proceed with due care.

CALIBRATE

( ) Plug in the VTVM and temporarily remove the phone plug from the jack. Set the Range switch to 1.5 V and the Function switch to AC. Adjust the AC Balance control so no movement is detected when switching from AC through DC- to DC+. Now set the Range switch to 150 V and the Function switch to AC. Reinsert the phone plug. Connect the test probe set on AC and the common lead across the 117 volt AC line.

Adjust the AC Calibrate control until the pointer indicates the line voltage (117 volts AC).

( ) Install the cabinet.

NOTE: The power consumption of the VTVM is very low and there is no objection to leaving the instrument on continuously during the daily work period rather than turning it off each time a measurement function is completed. Daily operation for a period of several hours or more will also serve the purpose of minimizing possible moisture accumulation.

SPECIFICATIONS

Electronic DC Voltmeter -
7 Ranges - 0-1.5, 5, 15, 50, 150, 500, 1500 volts full scale; up to 30,000 volts with accessory probe.
Input Resistance - 11 megohms (1 megohm in probe) on all ranges; 1100 megohms with accessory probe.
Sensitivity - 7,333,333 ohms-per-volt on 1.5 volt range.
Circuit - Balanced bridge (push-pull) using twin triode.
Accuracy - ±3% full scale.

Electronic AC Voltmeter -
7 rms Ranges - 0-1.5, 5, 15, 50, 150, 500, 1500 rms scales (.353 of peak-to-peak).
7 Peak-to-Peak Ranges - 0-4, 14, 40, 140, 400, 1400, 4000.
Frequency Response (5 V range) - ±1 db 25 cps to 1 mc (600 Ω source).
Accuracy - ±5% full scale.
Input Resistance And Capacitance - 1 megohm shunted by 35 $\mu\mu$f (measured at input terminals).

Electronic Ohmmeter -
7 Ranges - Scale with 10 Ω center X1, X10, X100, X1000, X10K, X100K, X1MEG. Measures .1 Ω to 1000 megohms with internal battery.

Meter - 4-1/2", 200 μa movement, polystyrene case.
Probes - Combined AC-ohms-DC switching probe, single jack input for probe and ground connections.
Multipliers - 1% precision type.

Circuit Board - Printed circuit; etched metal process.

Tubes - 1 - 12AU7, twin triode meter bridge.
1 - 6AL5, twin diode AC rectifier.
Battery - 1-1/2 volt flashlight cell.
Power Requirements - 105-125 volts, 50/60 cps AC, 10 watts.

Cabinet Size and Finish - 7-3/8" high x 4-11/16" wide x 4-1/8" deep, charcoal gray.

Weight - 5 lbs.

CIRCUIT DESCRIPTION

The combination AC-OHMS-DC test lead of the VTVM is connected to the Function switch, which is used to choose the parts of the VTVM circuit needed for any of the VTVM measurement functions. The COMMON test lead is connected to the case (ground) of the instrument.

With the Function switch in the DC+ or DC- position and the switching probe on DC, the test voltage is applied through the 1 megohm resistor in the probe to the Range switch, which is a series of precision resistors arranged as a voltage divider. Depending on the position of the Range switch, a portion of this DC voltage is "picked off" and applied to the input grid of the 12AU7 tube.

With the Function switch in the AC position and the test probe on AC-OHMS, an AC test voltage is applied to the 6AL5 tube (half-wave doubler circuit) where it is changed to a DC voltage which is proportional to the applied AC test voltage. On the higher AC ranges, a voltage divider arrangement is used at the input of the 6AL5 tube to insure that the AC voltage applied to the 6AL5 tube does not exceed the tube's rating. The DC voltage output of the 6AL5 tube is applied to the Range switch and then to the input grid of the 12AU7 tube, in the same way that DC test voltages are applied. A capacitor is used at the output of the 6AL5 to hold the applied pulsating DC voltage at its peak value, so that the VTVM responds to peak voltage regardless of the test voltage waveform. The AC balance control is used to "buck-out" the small amount of contact potential in the 6AL5 tube, thus eliminating residual readings on the lower AC ranges.

The ohmmeter section of the VTVM uses a 1.5 volt battery connected in series with part of the voltage divider network (determined by the Range switch position) and the resistance to be measured. The ratio between the ohmmeter voltage divider network resistors and the measured resistance determines what portion of the ohmmeter battery voltage is applied to the input grid of the 12AU7 tube.

Thus, for all measurement functions, a voltage dependent upon the quantity being measured is applied to the grid of one-half of the 12AU7 twin triode. With zero voltage input to the 12AU7 balanced bridge circuit, each of its triode sections draws the same amount of cathode current and therefore each cathode is of the same voltage potential. The meter movement is connected between the cathodes of the 12AU7 tube and consequently will not deflect since both cathodes are at the same potential.

When a positive voltage (from the Range switch) is applied to one-half of the 12AU7 tube, this half of the tube draws more current than the other half, causing a difference in cathode potential between the two tube sections. Since the meter is connected between the two cathodes, a current flows through the meter movement. The meter pointer responds proportionally to this current, indicating the value of voltage or resistance being measured. The DC+ and DC- switch positions are used to reverse the meter connections between the cathodes so that current always flows through the meter in the same direction.

The use of the bridge circuit eliminates any change in the voltage reading if the B+ voltage in the VTVM should vary since the resulting variation in tube conduction will occur in both triodes and, therefore, will not affect the difference in cathode potential. Also, the maximum conduction characteristic of the 12AU7 tube, as used in the VTVM circuit, is such that the voltage applied to the meter terminals cannot be large enough to damage the meter movement. This is one of the primary advantages of the VTVM circuit. The meter movement cannot be burned out by inadvertently measuring a voltage that is higher than the Range switch setting. However, if excessive voltage is applied, the pointer may be bent as it hits against the stop. Caution must also be exercised to avoid applying any test voltage to the test probe when the Function switch is set in the OHMS position. The precision resistors in the ohmmeter voltage divider network have very low power ratings and can easily be burned out in this way.

The power supply of the VTVM uses a selenium rectifier in a half-wave rectifier circuit. An electrolytic capacitor is used for filtering the DC voltage from the power supply. The power supply provides both B+ voltage for the 12AU7 tube and DC "buck-out" voltage for the AC balance circuit.

MAINTENANCE

NOTE: Refer to the Model Number and Series Number on the blue and white identification label in any communications you have with the Heath Company about this unit.

METER

Because of the delicate nature of the meter movement, no attempt should be made to repair the meter. Such attempts would automatically void the standard warranty coverage of the meter itself.

METER COVER

If the polystyrene meter cover is accidentally damaged, a replacement cover only is available from the Heath Company. This cover can be easily removed without detaching the meter from the panel. Use a small screwdriver or knife blade under one of the upper corners and pop off the friction-fit cover. When installing a new cover, precaution should be observed regarding proper engagement of the mechanical zero adjust stud. If it is necessary to expose the meter movement to air for a period of time, protect the movement from foreign matter, dust, etc., by enclosing the instrument in a box or possibly in a desk drawer.

ELECTROSTATIC CHARGE

The polystyrene meter cover has been treated to resist an accumulation of static electricity. However, should a static charge accumulate through repeated polishing or cleaning of the meter cover, the pointer will deflect in an erratic manner, regardless of whether the instrument is turned off or on. This condition can be corrected quickly. Apply a small quantity of liquid dishwashing detergent to a clean, soft cloth and wipe the surface of the meter cover. The accumulated electrostatic charge will immediately disappear. It is not necessary to remove the cover for this correction.

CHECKING METER COIL CONTINUITY

If failure of the meter coil is suspected, continuity can be determined by observing the following precaution. NEVER check meter movement continuity directly with another ohmmeter. The amount of current drawn will seriously overload the meter coil and will certainly result in a definite open circuit condition. Always use a limiting resistor in series with the ohmmeter test leads. The value of the resistor will depend upon the ohmmeter battery voltage and range on which the ohmmeter is being used. Always use at least a 10,000 Ω resistor in series with the VTVM meter coil and the ohmmeter test leads.

TEST LEADS

Because of their constant flexing during use, the test leads are not above suspicion, especially when the VTVM has been in use for several years. Erratic or improper DC voltage measurements can sometimes be caused by a fault in the shielded test lead or in the connection of the 1 megohm isolating resistor used in the test probe.

ACCESSORY PROBES

HIGH VOLTAGE TEST PROBES

A high voltage test probe is available from the Heath Company. This probe will permit VTVM DC measurements up to 30,000 volts, which covers the range of flyback power supply voltages commonly encountered in TV receivers. This probe consists of red molded housing with black molded handle. It contains a 2% precision, 1090 megohm resistor and provides a DC range multiplication factor of 100 for 11 megohm input VTVMs.

Older model high voltage probes may be converted for use in the IMW-11 by making a ground connection from an alligator clip lead to the body of the probe phone plug.

RF TEST PROBE

A RF test probe is available from the Heath Company. This probe will permit VTVM usage for RF measurements up to 30 volts, substantially flat from 1000 cps to 100 mc. A built-in isolating capacitor permits DC voltage range up to 500 volts. It uses a printed circuit board for easy assembly and its housing is of polished aluminum with polystyrene insulation.

TROUBLESHOOTING CHART

COMPLETELY INOPERATIVE

1. Make sure that power is being applied to the instrument. This may be measured across the primary winding of the power transformer (black leads, 117 volts AC).
2. If pilot lamp and tube filaments do not light, check voltage between the yellow leads of power transformer (5-6 volts AC).
3. Check voltage between each end of electrolytic capacitor and ground. Correct voltages are shown on the Schematic.
4. Check the 12AU7 tube.

INABILITY TO OBTAIN DC BALANCE

1. Check the 12AU7 tube for an unbalanced condition (Subsitution).
2. Check the 10 megohm resistor, R32 (brown-black-blue).
3. Check the two .005 capacitors C5 and C6 in grid circuits of the 12AU7 tube (Pins 2 and 7).
4. Check the components in the cathode circuits of the 12AU7 tube (Pins 3 and 8). These circuits include the ZERO ADJ control, R1, R33, R34, and R35.

AC INOPERATIVE

1. Check the 6AL5 tube.
2. Check C2, .047 μfd 1600 volt, and the two .02 μfd capacitors, C3 and C4.

AC BALANCE

1. Disconnect test leads from instrument before adjusting the AC Balance control as directed in the manual.
2. It is imperative that DC balance be obtained before this adjustment is made.

INACCURATE AC READINGS (The inability to obtain AC calibration).

1. Check capacitors C1, C3, and C4.
2. Check the 6AL5 tube.
3. Check the AC Calibrate control, R3. NOTE: With the test lead plug inserted, there may be a residual reading. This is due to stray AC pickup in the test leads and can be attributed to the instrument's excellent sensitivity. Readings on the two lower AC ranges will normally be slightly low.

INACCURATE DC READINGS

1. Check the DC calibrate control, R4.
2. Check resistor in the test probe. Make sure that it is not being grounded.

OHMS INOPERATIVE

1. Check the OHMS ADJ control, R2, for correct value.
2. Check Range switch proper assembly.

OHMS INACCURATE

1. Check the battery (Subsititution).
2. Check the value of all resistors on the range switch which have a value beginning with the number "9." (The 9.1 Ω R31 should receive special attention.) NOTE: The ohms section of the VTVM is not intended for use as a standard. Where a great degree of accuracy is required, a bridge should be used.

REPLACEMENT PARTS

PART No.	DESCRIPTION
Resistors	
1-3	100 Ω 1/2 watt
1-20	10 KΩ 1/2 watt
1-23	27 KΩ 1/2 watt
1-27	150 KΩ 1/2 watt
1-29	220 KΩ 1/2 watt
1-35	1 megohm 1/2 watt
1-38	3.3 megohm 1/2 watt
1-40	10 megohm 1/2 watt
1-70	22 megohm 1/2 watt
3B-4	9.1 Ω 5% precision 1/2 watt

PART No.	DESCRIPTION
Resistors (Cont'd.)	
2-24	90 Ω 1/2 watt precision
2-29	900 Ω 1/2 watt precision
2-35	9 KΩ 1/2 watt precision
2-50	10 KΩ 1/2 watt precision
2-38	20 KΩ 1/2 watt precision
2-9	70 KΩ 1/2 watt precision
2-41	90 KΩ 1/2 watt precision
2-86	150 KΩ 1/2 watt precision
2-54	200 KΩ 1/2 watt precision
2-87	320 KΩ 1/2 watt precision
2-13	700 KΩ 1/2 watt precision
2-51	900 KΩ 1/2 watt precision
2-55	2 megohm 1/2 watt precision
2-16	7 megohm 1/2 watt precision
2-52	9 megohm 1/2 watt precision
2A-28	900 KΩ 1 watt precision

PART No.	DESCRIPTION
Capacitors	
21-27	.005 μfd 400 V disc ceramic
21-31	.02 μfd 400 V disc ceramic
23-91	.047 μfd 1600 V tubular
25-5	16 μfd 150 V electrolytic
Controls-Switches	
10-78	15 KΩ control
10-38	10 KΩ control
63-79	Range switch
63-80	Function switch
Tubes-Lamps	
411-25	12AU7 tube
411-40	6AL5 tube
412-4	#50 pilot lamp
Probe Parts	
253-51	E washer
256-15	1/16" x 1/8" rivet

PART No.	DESCRIPTION
Probe Parts (Cont'd.)	
258-53	Probe contact loading spring
459-6	Probe switch lever
459-7	Probe insert insulator
476-13	Front section of probe body
476-14	Center section of probe body
476-15	Rear section of probe body
477-6	Probe spike
346-12	Probe spike rubber sleeve
Miscellaneous	
54-23	Power transformer
57-27	Silicon rectifier
203-278F601-602-603	Front panel
407-62	200 microampere meter
462-187	Knob
595-489	Manual

WARRANTY

The Heath Company warrants that its factory-wired products (except any batteries supplied therewith) shall be free of defects in materials and workmanship under normal conditions of use and service. The obligation of Heath under this warranty is limited to repairing or replacing any such factory-wired product upon verification that it is defective in this manner. This obligation is further limited to such defective products for which Heath is notified of the defect within a period of one year from the original date of shipment of the product.

The obligation of Heath under this warranty with respect to transportation expenses is limited to the cost of shipping the repaired or replacement product to the buyer, provided such repair or replacement comes within the terms of this warranty.

The foregoing warranty extends only to the original buyer and is expressly in lieu of all other warranties, expressed or implied. The foregoing warranty is further in lieu of all other obligations or liabilities on the part of Heath and in no event shall the Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, operation or use of the product.

This warranty applies only to Heath products sold and shipped to points within the continental United States and to APO and FPO shipments. Warranty replacements for Heath products sold or shipped outside the United States is on an f.o.b. factory basis. Contact the Heath authorized distributor in your country or write: Heath Company, International Division, Benton Harbor, Michigan, U.S.A.

HEATH COMPANY

The foregoing Warranty applies expressly to Direct Mail Customers with reference to Heath Company factory service and parts replacements.

If your unit was purchased through a local authorized Heath Dealer, all sections of this Warranty will be honored by such dealer.

HEATH COMPANY

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